Generation of the Solar Subsurface Shear

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Helioseismology has shown that there are two shear layers in the angular velocity distribution of the sun. The principal one is the one between the bottom of the convection zone and the radiative interior. This layer manifests the transition from an almost uniform rotation in the interior to the substantial differential rotation of the convection zone. The second shear layer is right beneath the surface of the sun, where the angular velocity changes by a few percent over a distance of $\sim 5\% R_\odot$.

We have recently made a parametric study of rotating convection using a large number of numerical experiments with different energy fluxes, rotation rates, and inclination of the rotation vector. Based on the results, we propose that the sharp change of angular velocity near the surface of the sun can be explained by the behavior of the rotating turbulence and the stratification (not by simple angular momentum conservation). This process is also compatible with a radially independent distribution of angular velocity in the deeper part of the convection zone. High-resolution calculations are used to illustrate the dynamics of the rotationally distorted turbulence and its roles in generating the angular velocity shear.